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(54) **SINGLE LEVER POWERPLANT CONTROL ON TWIN TURBOPROPELLER AIRCRAFT**

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(51) **Int. Cl.**

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CPC B64C 11/50; B64C 11/305; B64D 31/12; B64D 31/00

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See application file for complete search history.

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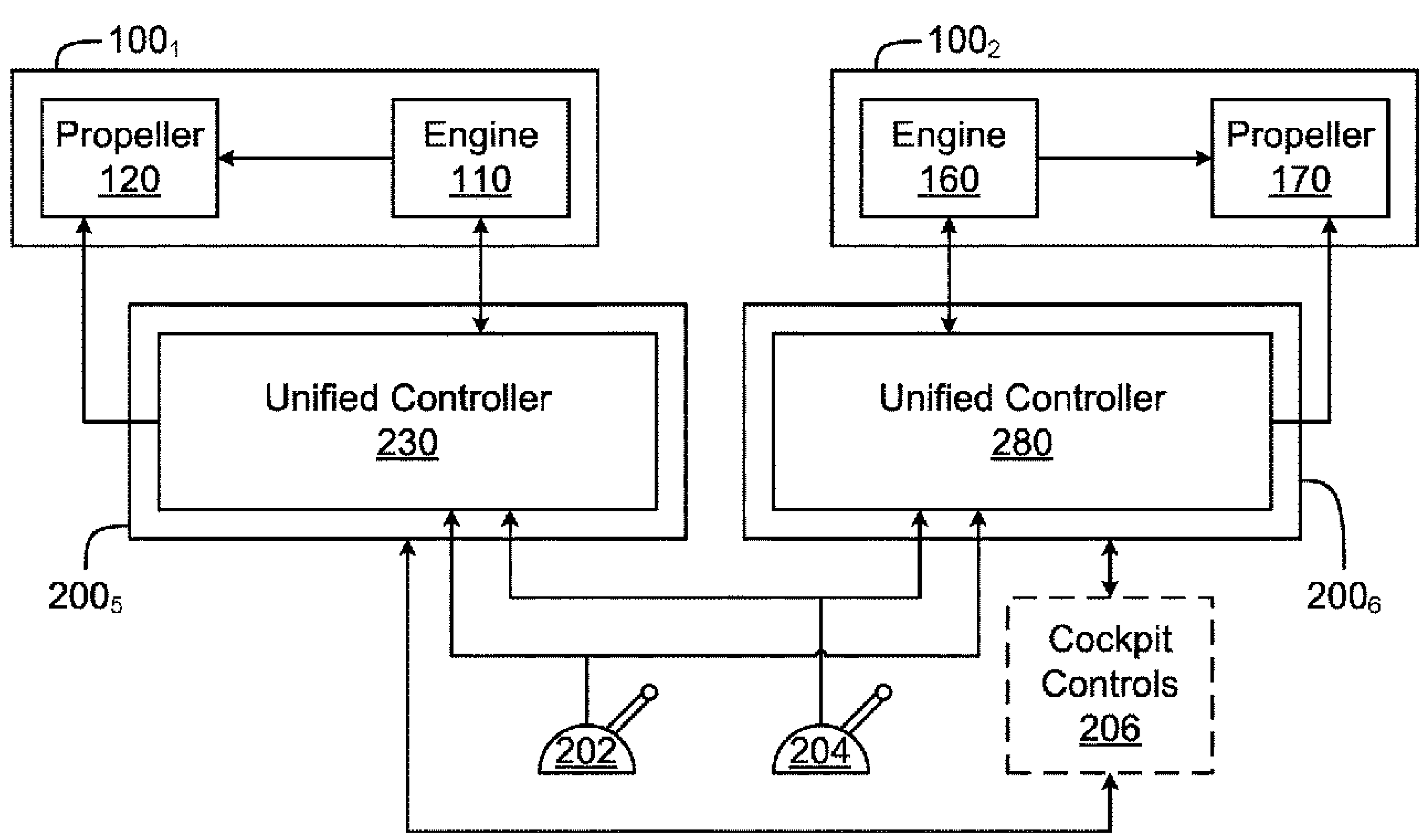
(57) **ABSTRACT**

Herein provided are methods and systems for controlling operation a first propeller of an aircraft, the first propeller associated with a first engine, the aircraft further comprising a second propeller associated with a second engine. A first requested engine power for the first engine is obtained. A second requested engine power for the second engine is obtained. The first propeller is synchronized with the second propeller by setting a first propeller command for the first propeller based on the first and second requested engine power, and the first propeller command is sent for the first propeller.

10 Claims, 8 Drawing Sheets



(51) **Int. Cl.**
B64D 31/06 (2006.01)
B64D 31/00 (2006.01)

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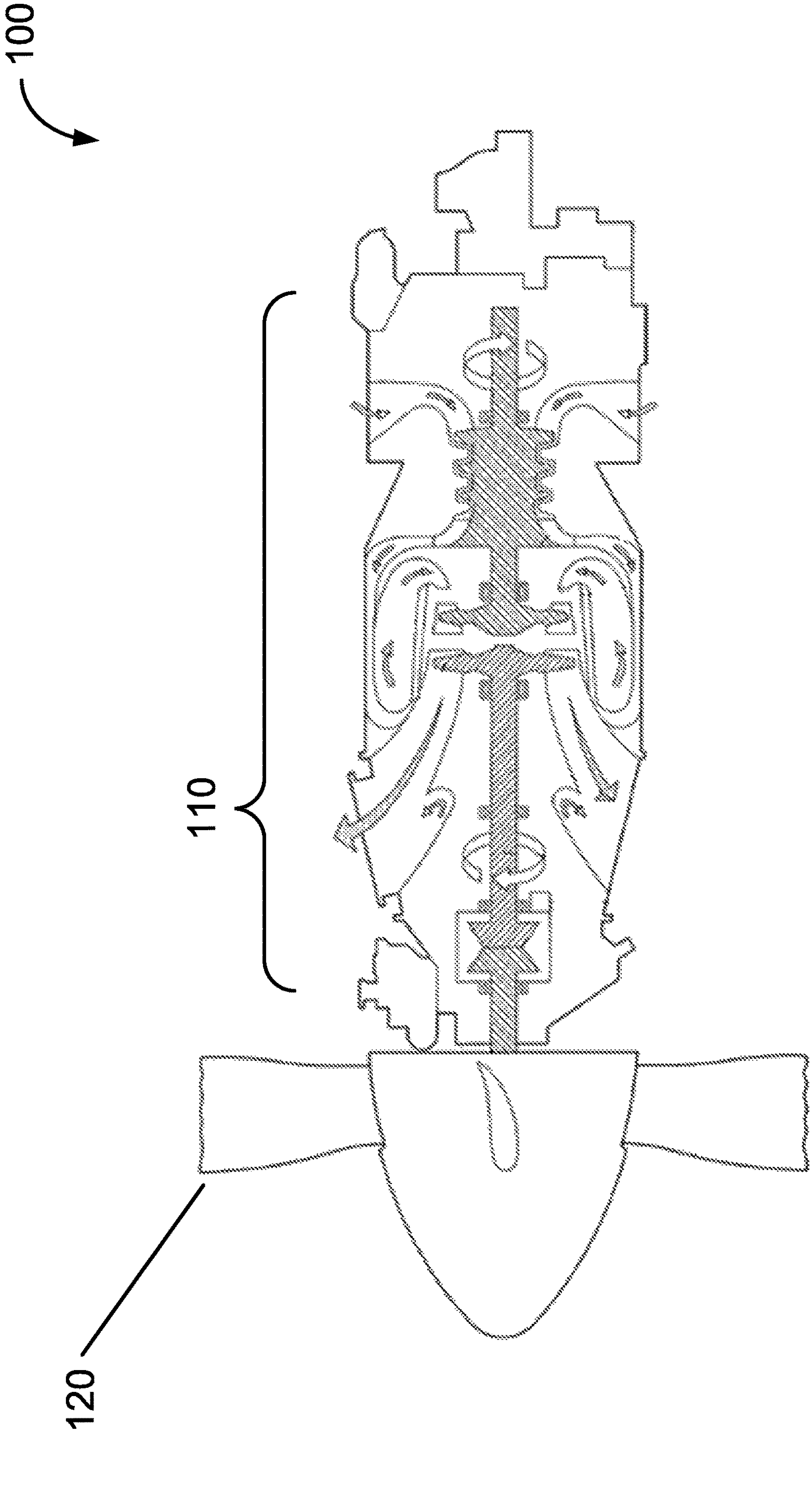


FIGURE 1

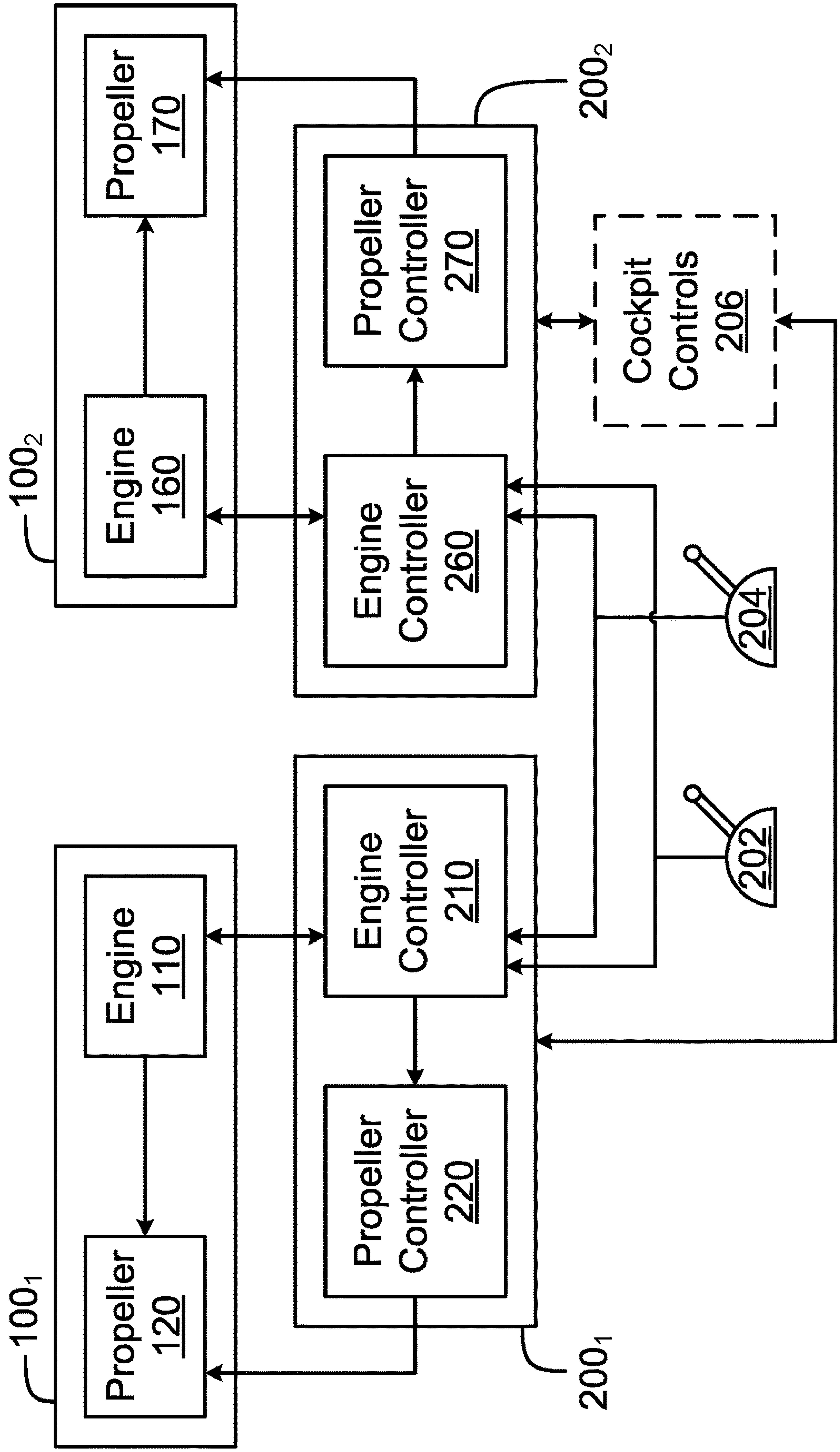
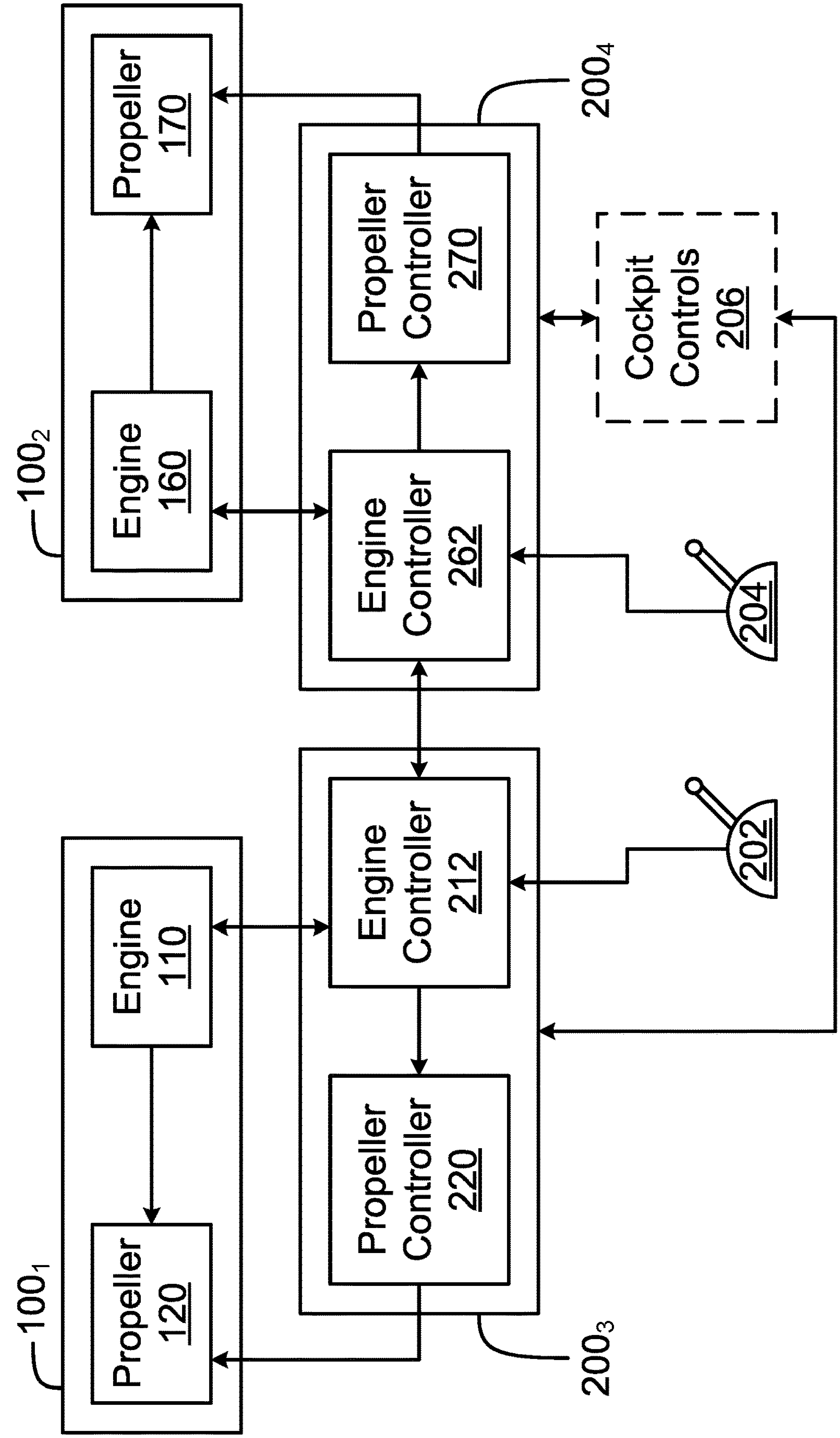

100_2
Engine
160
Propeller
170
Engine
Controller
260
Propeller
Controller
270
200_2
Cockpit
Controls
206
204
202
100_1
Propeller
120
Engine
110
Propeller
Controller
220
Engine
Controller
210
200_1

FIGURE 2A



100_2
Engine 160
Propeller 170
200_4
Propeller Controller 270
Engine Controller 262
Cockpit Controls 206
204
100_1
Engine 110
Propeller 120
Engine Controller 212
Propeller Controller 220
202
200_3

FIGURE 2B

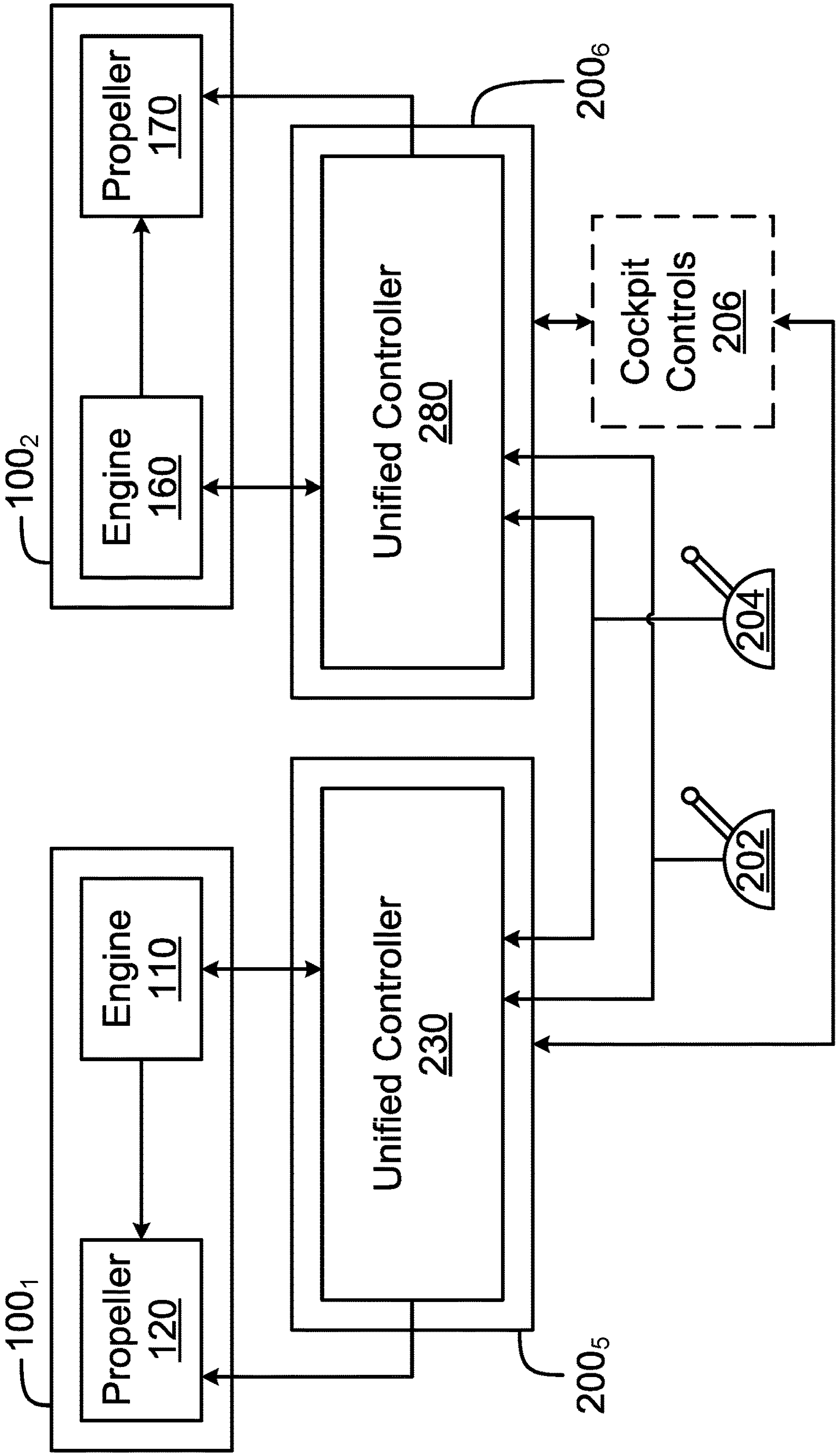

100_2
Engine 160
Propeller 170
Unified Controller 280
200_6
Cockpit Controls 206
204
202
Unified Controller 230
Engine 110
Propeller 120
100_1
200_5

FIGURE 2C

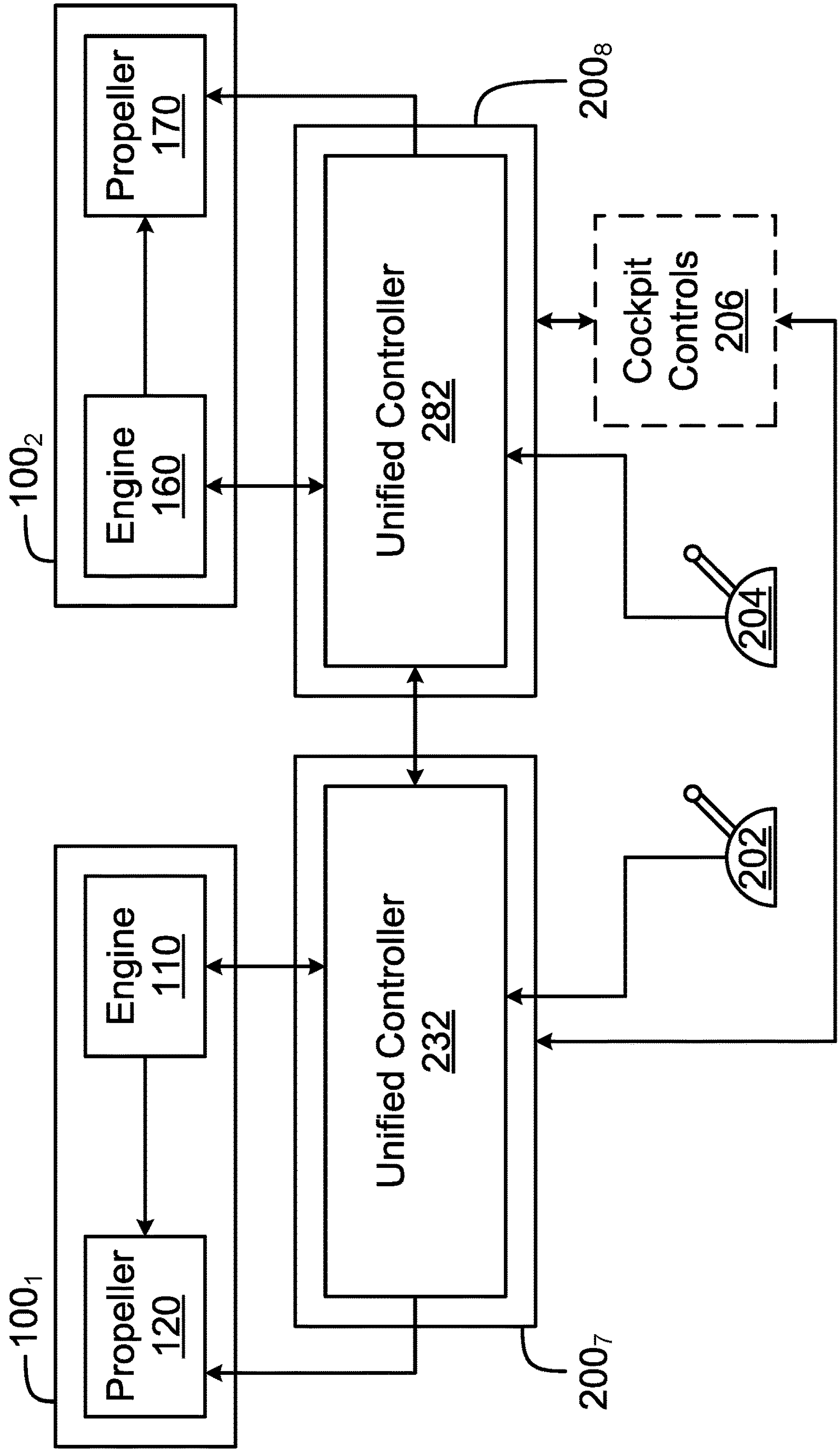

Propeller
170
Engine
160
100_2
Unified Controller
282
200_8
Cockpit
Controls
206
204
202
Engine
110
Propeller
120
100_1
Unified Controller
232
200_7

FIGURE 2D

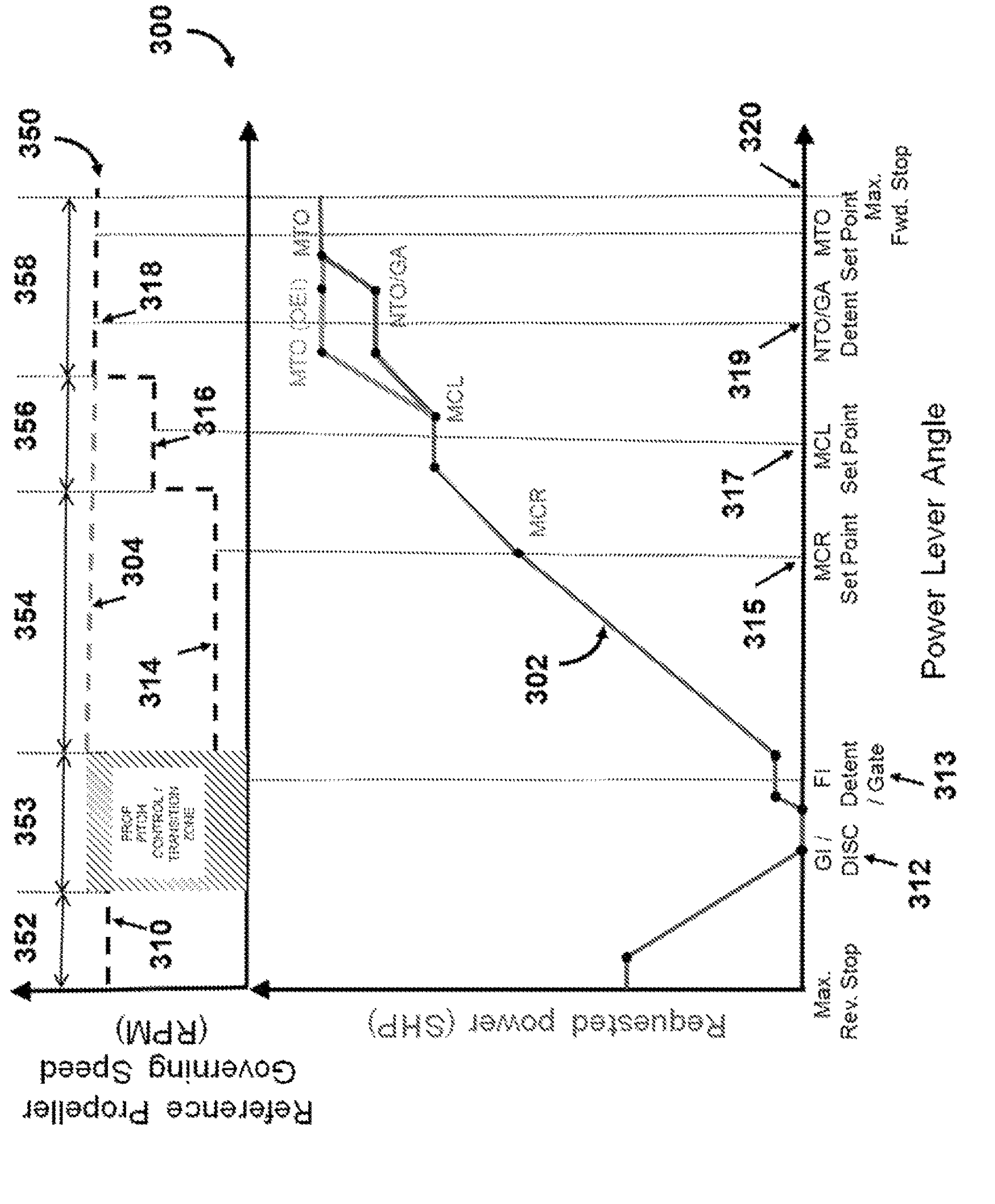

300
350
352
353
354
356
358
310
304
314
316
318
PROP PITCH CONTROL / TRANSITION ZONE
Reference Propeller Governing Speed (RPM)
Requested power (SHP)
302
MCR
MCL
MTO (OEI)
MTO
NTO/GA
Max. Rev. Stop
GI / DISC
312
FI Detent / Gate
313
315
MCR Set Point
317
MCL Set Point
319
NTO/GA Detent
MTO Set Point
Max. Fwd. Stop
320
Power Lever Angle

FIGURE 3

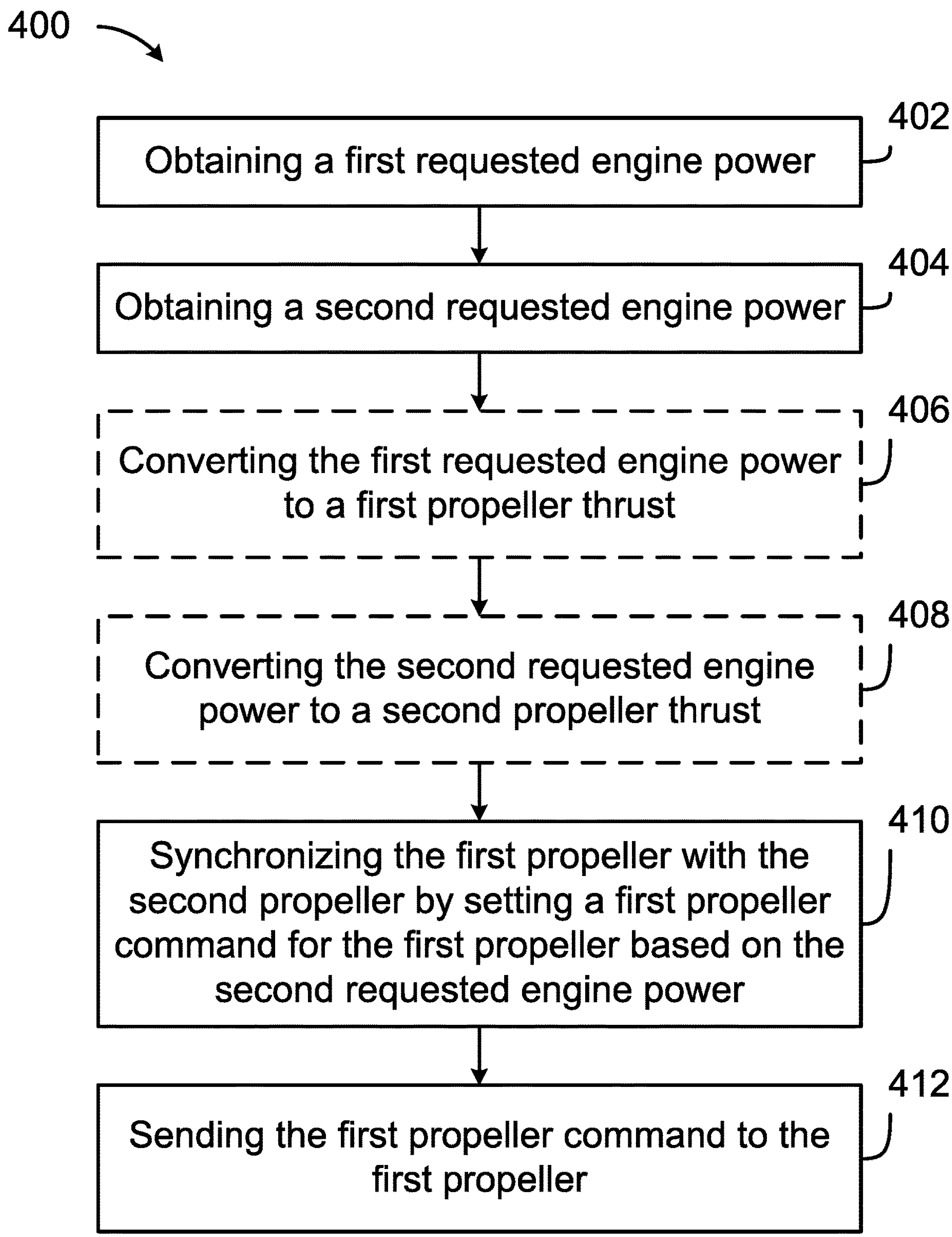

400
Obtaining a first requested engine power
402
Obtaining a second requested engine power
404
Converting the first requested engine power to a first propeller thrust
406
Converting the second requested engine power to a second propeller thrust
408
Synchronizing the first propeller with the second propeller by setting a first propeller command for the first propeller based on the second requested engine power
410
Sending the first propeller command to the first propeller
412

FIGURE 4

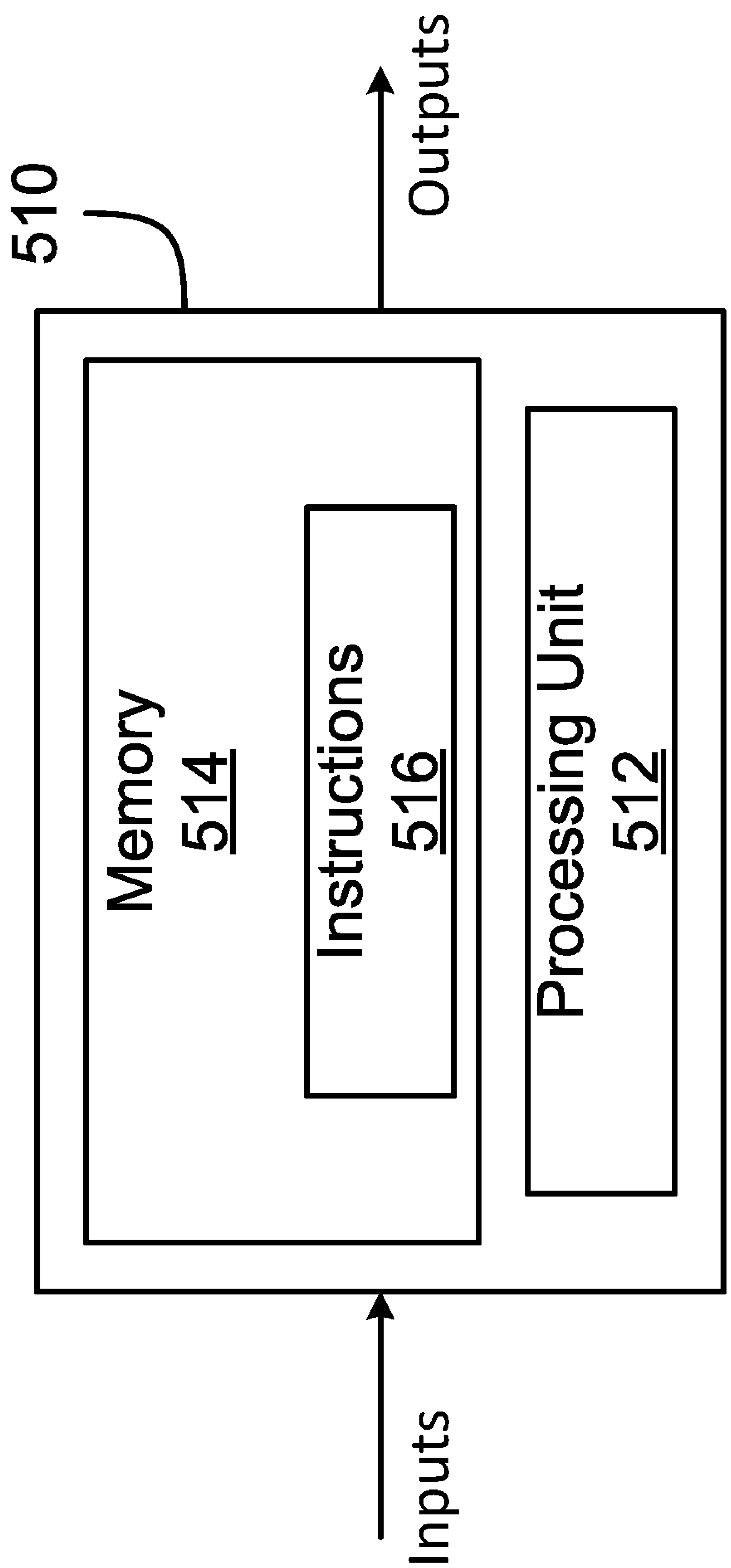

510
Outputs
Memory
514
Instructions
516
Processing Unit
512
Inputs

FIGURE 5

SINGLE LEVER POWERPLANT CONTROL ON TWIN TURBOPROPELLER AIRCRAFT

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a continuation of U.S. patent application Ser. No. 15/459,742 filed on Mar. 15, 2017 and which claims the benefit of U.S. Provisional Patent Application No. 62/462,090 filed on Feb. 22, 2017, the contents of which are hereby incorporated by reference in their entirety.

TECHNICAL FIELD

The present disclosure relates generally to engine control, and, more particularly, to engine and propeller control in aircraft.

BACKGROUND OF THE ART

A propeller-driven aircraft powerplant consists of two principal and distinct components: an engine and a propeller. An engine control system is used to modulate the power output of the engine, for example by controlling fuel flow to the engine. Similarly, a propeller control system is used to modulate the thrust produced by the propeller, for example by changing a propeller rotational speed and/or a propeller blade pitch. In traditional propeller driven aircraft, each of the engine control system and the propeller control system is operated by a pilot or other operator using a respective lever for each of the powerplant components: thus, a throttle lever is used to set a desired engine power output, and a condition lever is used to set a desired propeller rotational speed and blade pitch angle, thereby modulating the thrust output. In addition, modern turbopropeller driven aircraft operate the propeller at predefined fixed propeller rotational speeds, optimized to a flight phase of the aircraft.

However, the presence of multiple levers for each principal components of each powerplant can lead to additional work load for the pilot, especially in cases where the aircraft has multiple engines, such as twin turbopropeller aircraft.

As such, there is room for improvement.

SUMMARY

In one aspect, there is provided a method for controlling operation a first propeller of an aircraft, the first propeller associated with a first engine, the aircraft further comprising a second propeller associated with a second engine. A first requested engine power for the first engine is obtained. A second requested engine power for the second engine is obtained. The first propeller is synchronized with the second propeller by setting a first propeller command for the first propeller based on the first and second requested engine power, and the first propeller command is sent for the first propeller.

In another aspect, there is provided a system for controlling operation of at least a first propeller of an aircraft, the first propeller associated with a first engine, the aircraft further comprising a second propeller associated with a second engine. The system comprises at least one processing unit and a non-transitory computer-readable memory having stored thereon program instructions. The program instructions are executable by the at least one processing unit for obtaining a first requested engine power for the first engine, obtaining a second requested engine power for the second engine, synchronizing the first propeller with the second propeller by setting a first propeller command for the first propeller based on the first and second requested engine power, and sending the first propeller command for the first propeller.

In a further aspect, there is provided an aircraft subsystem comprising a first engine, a first propeller, and a first unified control lever associated with the first engine and the first propeller, a second engine, a second propeller, and a second unified control lever associated with the second engine and the second propeller, a first engine control system configured for controlling the first engine and the first propeller based on a first command from the first unified control lever, and a second engine control system configured for controlling the second engine and the second propeller based on a second command from the second unified control lever. At least one of the first engine control system and the second engine control system is configured for synchronizing the first propeller and the second propeller using the first command from the first unified control lever and the second command from the second unified control lever.

DESCRIPTION OF THE DRAWINGS

Reference is now made to the accompanying figures in which:

FIG. **1** is a schematic cross-sectional view of an example engine of an aircraft;

FIGS. **2**A-D are block diagrams of example powerplant control system configurations;

FIG. **3** is a graphical representation of example requested power and requested propeller governing speed curves;

FIG. **4** is a flowchart illustrating an example method for controlling the operation of a propeller of an aircraft in accordance with an embodiment; and

FIG. **5** is a schematic diagram of an example computing system for implementing the powerplant control systems of FIGS. **2**A-D in accordance with an embodiment.

It will be noted that throughout the appended drawings, like features are identified by like reference numerals.

DETAILED DESCRIPTION

With reference to FIG. **1**, there is illustrated a turbopropeller powerplant **100** for an aircraft of a type preferably provided for use in subsonic flight, generally comprising an engine **110** and a propeller **120**. The propeller **120** converts rotary motion from a shaft of the engine **110** to provide propulsive force for the aircraft, also known as thrust. The powerplant **100** of FIG. **1** is a turboprop, but the engine **110** could also be any other type of engine mated to a propeller **120**, such as a piston engine, and the like.

Operation of the engine **110** and of the propeller **120** can be regulated by a pilot or other operator by way of various powerplant controls. Traditionally, a turbopropeller driven aircraft is provided with a throttle lever (also referred to as a power lever), which is used to regulate the output power of the engine **110**, and a condition lever, which is used to regulate the propeller rotational speed and blade pitch angle thereby modulating thrust produced by the propeller **120**. For instance, the aircraft can include one throttle lever and one condition lever per powerplant **100**. For example, a twin turbopropeller aircraft having two separate powerplants **100** can have two throttle levers and two condition levers.

The present disclosure considers the use of a unified control lever (UCL) to control both the output power of the engine **110** and the thrust produced by the propeller **120**.

With reference to FIG. 2A, a first powerplant control system (PCS) **200**$_1$ and a second PCS **200**$_2$ are shown. PCS **200**$_1$, **200**$_2$ are configured for controlling operation of aircraft powerplants **100**$_1$ and **100**$_2$, respectively, each having an engine **110**, **160**, and a propeller **120**, **170**. PCS **200**$_1$ is configured for receiving input from a first UCL **202**, which is associated with the first powerplant **100**$_1$, and from a second UCL **204**, which is associated with the second powerplant **100**$_2$. Similarly, PCS **200**$_2$ is configured for receiving input from first and second UCLs **202**, **204**. Optionally, the PCS **200**$_1$, **200**$_2$ are further configured for receiving additional input from cockpit controls **206**.

The UCLs **202**, **204** each provide to PCS **200**$_1$, **200**$_2$ a respective lever position, for example based on the angle of the lever vis-à-vis a predetermined reference position. In addition, in some embodiments the cockpit controls **206** include buttons, switches, dials, or other discrete-type input mechanisms which may be located on or proximate the UCLs **202**, **204** and which can provide additional input to the PCS **200**$_1$, **200**$_2$. For example, the discrete-type input mechanisms can provide information regarding the propeller reference speed, fuel on/off, propeller feather/unfeather, and the like. The lever position, and optionally the additional input from the cockpit controls **206**, can be provided to each one of PCS **200**$_1$, **200**$_2$ using any suitable signalling protocol and over any suitable communication medium. In some embodiments, each one of PCS **200**$_1$, **200**$_2$ receives the lever position and the additional input via one or more wires, either as a digital signal or as an electrical analog signal. In other embodiments, the UCLs **202**, **204** can communicate the lever position and the cockpit controls **206** can communicate the additional input to PCS **200**$_1$, **200**$_2$ over one or more wireless transmission protocols. In some embodiments, an aircraft will have one UCL per engine powerplant.

PCS **200**$_1$, **200**$_2$ each include an engine controller **210**, **260**, and a propeller controller **220**, **270**. The engine controllers **210**, **260** are configured for receiving the lever positions from each of the UCLs **202**, **204**, and optionally the additional input from the cockpit controls **206**. The lever position and the additional input can be transmitted from the UCLs **202**, **204** and from the cockpit controls **206** to the engine controller **210**, **260** in any suitable fashion and using any suitable communication protocol. The following discussion focuses on the operation of one of the engine controllers, namely engine controller **210**, but it should be understood that engine controller **260** may be configured to perform similar operations.

The engine controller **210** is configured for processing the lever positions for associated UCL **202**, and any additional input from the cockpit controls **206**, to obtain a requested engine output power for the engine **110**. Based on the requested engine output power, the engine controller **210** produces an engine control signal which is sent to the associated engine **110** to control the operation of the engine **110**. In some embodiments, the engine control signal modulates a flow of fuel to the engine **110**. In other embodiments, the engine control signal alters the operation of a gear system of the engine **110**. Still other types of engine operation control are considered.

The engine controller **210** is further configured for processing the lever position and any additional input received from the UCL **204** and from the cockpit controls **206** to obtain a requested engine output power for the engine **160**. Put differently, the engine controller **210** will process the lever position for both UCLs **202**, **204**, and optionally the additional input from the cockpit controls **206** to obtain two separate requested engine output power, one for the engine **110** and one for the engine **160**. The engine controller **260** may also be configured to obtain the requested engine output power for the engines **110**, **160**.

Then, based on the requested engine output power for the engine **160** as derived from UCL **204**, the engine controller **210** can determine a first propeller command for the propeller **120**. For example, the engine controller **210** can use a lookup table, an algorithm, or any other suitable methodology to determine the required rotational speed by the propeller **120** based on the requested engine output power for the engine **160**, which in turn can inform the propeller controller **220** on required propeller rotational speed and/or blade pitch angle for the propeller **120**. In some embodiments, the engine controller **210** determines a propeller governing speed reference via a lookup table or algorithm. The engine controller **210** determines the propeller governing speed reference for the propeller **120** to ensure that the propeller governing speed references for the propeller **120** and the propeller **170** are synchronized. In some embodiments, synchronization of the propeller governing speed references for the propeller **120** and the propeller **170** requires that the propeller governing speed references are the same for both propellers **120**, **170**. Put differently, the engine controller **210** sets the first propeller command for the first propeller **120** to cause the first propeller **120** to operate based on the requested power for the second engine **160**, causing the propellers **120**, **170** to operate in a follower-leader configuration.

In some embodiments, the selection of the propeller governing speed references is a function of the lever position for the UCL **204** which has a plurality of transition points or "breakpoints" at which requested propeller governing speeds change, and optionally of the cockpit controls **206**. The breakpoints may align with aircraft flight modes or phases, or with certain emergency conditions. For example, in situations where one or more propellers are to be secured either via feathering or by shutting down the powerplant(s) associated with the one or more propellers.

For example, and with reference to FIG. **3**, a lookup table **300** can be used to map the requested engine power and/or the propeller thrust to a requested propeller governing speed. A curve **302** shows a relationship between the lever angle for a UCL (horizontal axis) and the requested power for an engine (vertical axis), for example the UCL **202** and the engine **110**, and a curve **350** shows a relationship between the lever angle for the UCL (horizontal axis) and the requested propeller governing speed for a propeller (vertical axis), for example the propeller **120**. The curve **302** is aligned with the curve **350**, which share a common horizontal axis, and points on the curve **302** can be mapped with a relation to points on the curve **350**.

For example, a first section **352** of the curve **350** dictates the reference propeller governing speed **310** between a maximum reverse position setpoint **311** and ground idle gate (GI) **312**. A second section **353** is implemented to adjust the reference propeller governing speed between the GI gate and a flight idle gate (FI) detent **313**. In this zone, the propeller control system blade angle is adjusted directly for a smooth transition and the transition point can vary as a function principally of forward speed. A third section **354** dictates the reference propeller governing speed **314** between the FI gate **313** and an intermediate point between a maximum cruise (MCR) set point **315** and a maximum climb (MCL) set point **317**. A fourth section **356** dictates the requested propeller governing speed **316** between the intermediate point between MCR set point **315** and MCL set point **317** and an intermediate point between the MCL set point **317** and a normal takeoff (NTO) detent **319**. A fifth section **358** dictates the requested propeller governing speed **318** between the intermediate point between MCL set point **317** and NTO detent **319** and a maximum forward UCL position **320**. In some embodiments, an alternate curve **304** can be followed in case of an unexpected event for one of the engines. Other methods of translating the requested engine power and/or the propeller thrust are also considered.

Referring again to FIG. **2**A, the engine controller **210** is further configured for sending the first propeller command to the first propeller **120**. In the embodiment of FIG. **2**A, the engine controller **210** is configured to send the first propeller command to the propeller controller **220**, which in turn uses the first propeller command to control operation of the propeller **120**. For example, the propeller controller **220** produces a propeller control signal indicative of the first propeller command and sends the propeller control signal to the propeller **120** to alter a propeller blade pitch, a rotational governing speed, or any other suitable propeller operating condition.

As discussed hereinabove, some or all the functionality which is implemented by the engine controller **210** may be mirrored by the engine controller **260**. In some embodiments, the engine controller **260** receives the lever positions for the UCL **204** and optionally any additional information from the cockpit controls **206**, obtains the requested engine power for the engine **160**, sets a second propeller command for the second propeller **170** based on second requested engine power, and sends the second propeller command to the second propeller **170**, for example via the propeller controller **270**. Since both engine controllers **210**, **260** perform the same functionality with respect to propeller governing speed reference based on the same inputs, i.e. the input received from the UCL **204** and any additional input from the cockpit controls **206**, the operation of the propellers **120**, **170** is synchronized. This ensures that even in the case of a mismatch of requested engine power for the engines **110**, **160**, the operation of the propellers **120**, **170** is synchronized, thereby avoiding undesirable propeller speed mismatch for the aircraft. For example, if the UCLs **202**, **204** are positioned at different angles, for example by the pilot, leading to different requested engine power for the engines **110**, **160** and basic propeller governing speed settings, the engine controllers **210**, **260** can correct the imbalance by adjusting the propeller governing speed reference, for example by setting first and second propeller commands to result in common propeller rotation speeds for both propellers **120**, **170**. In some embodiments, this synchronization can be overridden, for example by a pilot or other operator, or by other control systems, for example in emergency situations.

The synchronization of the operation of the propellers **120**, **170** can be performed in one or more fashions. In some embodiments, if the first requested engine power for engine **110** is lower than the second requested engine power for engine **160** and, for example, if the rotational governing speed for the first propeller **120** is lower than for the second propeller **170**, the first propeller command is set to increase the rotational speed of the propeller **120** to the rotational speed of the propeller **170**. In another embodiment, if the first requested engine power for engine **110** is lower than the second requested engine power for engine **160** and, for example, if the rotational governing speed for the first propeller **120** is lower than for the second propeller **170**, the first propeller command is set to increase the rotational speed of the propeller **120** to the rotational speed of the propeller **170**. Still other synchronization techniques are considered. In some embodiments, the synchronization technique used depends on the requested engine power for the engines **110**, **160**, based on propeller thrust for the propellers **120**, **170**, and/or based on any additional input provided by the cockpit controls **206**.

In some embodiments where the aircraft has additional powerplants beyond the powerplants $\mathbf{100}_1$, $\mathbf{100}_2$, the PCS $\mathbf{200}_1$, includes one engine-controller-and-propeller-controller pair for each additional powerplant present in the aircraft. In other embodiments, the PCS $\mathbf{200}_1$, includes only the two engine-controller-and-propeller-controller pairs **210**, **220** and **260**, **270**, that is to say one engine-controller-and-propeller-controller pair for each side or wing of the aircraft. In still further embodiments, the PCS $\mathbf{200}_1$, includes any suitable number of engine-controller-and-propeller-controller pairs. In embodiments where an aircraft has a plurality of powerplants **100** for each side or wing of the aircraft, a first side can be designated as leader, and the second side is designated as follower, such that the propellers of the second side are synchronized to match the operation of the propellers of the first side. In addition, in some embodiments, each of the additional powerplants is associated with a respective UCL, such that there are an equal number of powerplants and UCLs.

With reference to FIG. **2**B, in some embodiments PCS $\mathbf{200}_3$, $\mathbf{200}_4$ are provided, each including a respective engine controller **212**, **262**. The engine controllers **212**, **262** are configured to receive the lever position from a respective one of the UCLs **202**, **204** and optionally the additional input from the cockpit controls **206**. In addition, the engine controllers **212**, **262** are configured for communicating with one-another. For example, if the propeller **120** is the follower to the propeller **170**, which is the leader, the engine controller **212** can obtain the requested engine power for the engine **110** associated with the propeller **120** from the received lever position of the UCL **202**, and can communicate with the engine controller **262** to obtain the requested propeller governing reference for the propeller **170**. In some embodiments, the engine controller **262** can provide the requested engine power for the engine **160** to the engine controller **212** directly. In other embodiments, the engine controller **262** provides the received lever position of the UCL **204** and any other additional data to the engine controller **212**, which can be used by the engine controller **212** to determine the requested engine power for the engine **160**.

With reference to FIG. **2**C, in some embodiments PCS $\mathbf{200}_5$, $\mathbf{200}_6$ are provided, each having a respective unified controller **230**, **280**. Each unified controller **230**, **280** is configured for implementing the functionality of one of the engine controllers **210**, **260**, and one of the propeller controllers **220**, **270**. In embodiments where the propeller **120** is the follower to the propeller **170**, the unified controller **230** is configured to receive the lever positions for the UCLs **202**, **204**, obtain the requested engine power for the engines **110**, **160**, set a first propeller command for the first propeller **120** based on the second requested engine power, and send the first propeller command to the propeller **120**. The unified controller **280** can implement similar functionality for the engine **160** and the propeller **170**.

With reference to FIG. **2**D, in some embodiments PCS $\mathbf{200}_7$, $\mathbf{200}_8$ are provided, each having a unified controller **232**, **282**. Each unified controller **232**, **282** is configured for implementing the functionality of one of the engine controllers **212**, **262**, and one of the propeller controllers **212**, **262**. The unified controller **232** is configured to receive the lever position from the UCL **202** and any additional information from the cockpit controls **206**, and to communicate with the unified controller **282** to obtain the requested engine power for the engine **160**, either directly or based on the lever position and any additional information for the UCL **204** this is then used by unified controller **232** to set the propeller governing speed for propeller **120**.

In each of the embodiments of FIGS. 2A-D, the operation of the propellers **120**, **170** is synchronized based on the lever positions of the UCL **204**, and any additional inputs provided via the cockpit controls **206**, to ensure that the various powerplants 110_1, 110_2 are operating the propellers **120**, **170** in a synchronized manner. In some embodiments, this is done by ensuring that the same propeller governing speed reference is used for both propellers **120**, **170**. Additionally, while propeller **120** is designated as the follower to propeller **170**, which is the leader, it should be noted that in other embodiments or configurations either of the propellers **120**, **170** can be designated as the leader, with the other as the follower.

With reference to FIG. **4**, there is shown a flowchart illustrating an example method **400** for controlling operation of a first propeller of an aircraft. The method **400** can be implemented by the engine controllers **210**, **212**, or by the unified controllers **230**, **232** hereinafter referred to as an engine control system, in embodiments where the propeller **120** is a follower to the propeller **170**. At step **402**, the engine control system obtains a first requested engine power, for example for the engine **110**. The first requested engine power can be obtained from a lever angle of a first unified control lever, for example the UCL **202**. In some embodiments, the engine control system uses a lookup table or algorithm or other technique to translate the lever angle into the requested engine power.

At step **404**, the engine control system obtains a second requested engine power, for example for the engine **160**. The second requested engine power can be obtained from a lever angle of a second unified control lever, for example the UCL **204**. In some embodiments, the engine control system uses a lookup table or algorithm or other technique to translate the lever angle into the requested engine power. Alternatively, the second requested engine power can be obtained from a separate engine control system, for example the engine controllers **260**, **262** or the unified controllers **280**, **282**, either as a lever angle or as the requested engine power itself.

At step **406**, optionally the engine control system converts the first requested engine power to a first propeller thrust. At step **408**, optionally the engine control system converts the second requested engine power to a second propeller thrust. The conversion of the first and second requested engine power to first and second propeller thrust can be performed with the use of a lookup table, an algorithm, or any other suitable technique. In some embodiments, converting the requested engine power to propeller thrust is based at least in part on additional input received from the UCL **202**, **204**.

At step **410**, the engine control system sets a first propeller command for a first propeller, for example propeller **120**, based on the second requested engine power. In particular, the first propeller command is set so as to synchronize the operation of the first propeller with the operation of a second propeller, for example propeller **170**. The synchronization of the operation of the first and second propellers **120**, **170** ensures that undesirable propeller governing speed mismatch are avoided by having both the first and second propellers adjust their respective propeller speeds to cause the propellers **120**, **170** to rotate in a synchronized fashion. Therefore, even if the first and second requested engine power are different, the engine control system can correct for the propeller governing speed mismatch by setting an appropriate first propeller command to produce equivalent behaviour for the first and second propellers.

At step **412**, the first propeller command is sent to the first propeller **120**. The first propeller command can be sent using any suitable means and any suitable protocol. For example the command can be sent using fly-by-wire technology and/or fly-by-wireless technology.

With reference to FIG. **5**, the method **400** may be implemented by a computing device **510**, comprising a processing unit **512** and a memory **514** which has stored therein computer-executable instructions **516**. The processing unit **512** may comprise any suitable devices configured to implement the system **300** such that instructions **516**, when executed by the computing device **510** or other programmable apparatus, may cause the functions/acts/steps of the method **400** as described herein to be executed. The processing unit **512** may comprise, for example, any type of general-purpose microprocessor or microcontroller, a digital signal processing (DSP) processor, a central processing unit (CPU), an integrated circuit, a field programmable gate array (FPGA), a reconfigurable processor, other suitably programmed or programmable logic circuits, or any combination thereof.

The memory **514** may comprise any suitable known or other machine-readable storage medium. The memory **514** may comprise non-transitory computer readable storage medium, for example, but not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing. The memory **514** may include a suitable combination of any type of computer memory that is located either internally or externally to device, for example random-access memory (RAM), read-only memory (ROM), compact disc read-only memory (CDROM), electro-optical memory, magneto-optical memory, erasable programmable read-only memory (EPROM), and electrically-erasable programmable read-only memory (EEPROM), Ferroelectric RAM (FRAM) or the like. Memory **514** may comprise any storage means (e.g., devices) suitable for retrievably storing machine-readable instructions **516** executable by processing unit **512**.

In some embodiments, the computing device **510** can include one or more full-authority digital engine controls (FADEC), one or more propeller electronic control (PEC) units, and the like. In some embodiments, the engine controllers **210**, **212**, **260**, **262** are implemented as dual-channel FADECs. In other embodiments, the engine controllers **210**, **212**, **260**, **262** are implemented as two separate single-channel FADECs. In still further embodiments, one of the engine controllers, for example the engine controller **210**, is implemented as a dual-channel FADEC, and the other engine controller, for example the engine controller **260**, is implemented as a single-channel FADEC. In such an embodiment, the engine controller **260** may be configured to cause the propeller **170** to operate in a particular default mode, and the engine controller **210** is configured for adjusting the operation of the propeller **120** to synchronize the propeller **120** with the propeller **170**.

Additionally, in some embodiments the propeller controllers **220**, **270** are implemented as dual-channel PECs, or as two single-channel PECs, or any suitable combination thereof. The unified controllers **230**, **232**, **280**, **282** can be implemented as any suitable combination of FADECs, PECs, and/or any other suitable control devices. In some embodiments, the additional inputs provided by the cockpit controls **206** can be provided via one or more engine interface cockpit units.

The methods and systems for controlling operation of a first propeller of an aircraft described herein may be implemented in a high level procedural or object oriented programming or scripting language, or a combination thereof, to communicate with or assist in the operation of a computer system, for example the computing device **600**. Alternatively, the methods and systems for controlling operation of a first propeller of an aircraft may be implemented in assembly or machine language. The language may be a compiled or interpreted language. Program code for implementing the methods and systems for controlling operation of a first propeller of an aircraft may be stored on a storage media or a device, for example a ROM, a magnetic disk, an optical disc, a flash drive, or any other suitable storage media or device. The program code may be readable by a general or special-purpose programmable computer for configuring and operating the computer when the storage media or device is read by the computer to perform the procedures described herein. Embodiments of the methods and systems for controlling operation of a first propeller of an aircraft may also be considered to be implemented by way of a non-transitory computer-readable storage medium having a computer program stored thereon. The computer program may comprise computer-readable instructions which cause a computer, or in some embodiments the processing unit **512** of the computing device **510**, to operate in a specific and predefined manner to perform the functions described herein.

Computer-executable instructions may be in many forms, including program modules, executed by one or more computers or other devices. Generally, program modules include routines, programs, objects, components, data structures, etc., that perform particular tasks or implement particular abstract data types. Typically the functionality of the program modules may be combined or distributed as desired in various embodiments.

The above description is meant to be exemplary only, and one skilled in the art will recognize that changes may be made to the embodiments described without departing from the scope of the invention disclosed. Still other modifications which fall within the scope of the present invention will be apparent to those skilled in the art, in light of a review of this disclosure.

Various aspects of the methods and systems for controlling operation of a first propeller of an aircraft may be used alone, in combination, or in a variety of arrangements not specifically discussed in the embodiments described in the foregoing and is therefore not limited in its application to the details and arrangement of components set forth in the foregoing description or illustrated in the drawings. For example, aspects described in one embodiment may be combined in any manner with aspects described in other embodiments. Although particular embodiments have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from this invention in its broader aspects. The scope of the following claims should not be limited by the embodiments set forth in the examples, but should be given the broadest reasonable interpretation consistent with the description as a whole.

The invention claimed is:

1. A method for controlling operation of at least a first propeller of an aircraft, the first propeller associated with a first engine, the aircraft further comprising a second propeller associated with a second engine, the method comprising:

obtaining, at a first unified controller, a first requested engine power for the first engine, the first unified controller configured for controlling the first engine and the first propeller;

obtaining, at the first unified controller, a second requested engine power for the second engine;

synchronizing, via the first unified controller, the first propeller with the second propeller by setting a first propeller command for the first propeller based on the second requested engine power; and

sending, via the first unified controller, the first propeller command for the first propeller.

2. The method of claim **1**, wherein obtaining the first requested engine power comprises receiving a first throttle command based on a lever angle for a first throttle lever associated with the first engine.

3. The method of claim **2**, wherein obtaining the second requested engine power comprises receiving a second throttle command based on a lever angle for a second throttle lever associated with the second engine.

4. The method of claim **3**, wherein the second throttle is a second unified control lever also associated with the second propeller.

5. The method of claim **2**, wherein the first throttle is a first unified control lever also associated with the first propeller.

6. The method of claim **1**, wherein setting the first propeller command comprises setting the first propeller command to match a second propeller command for the second propeller based on the second requested engine power.

7. The method of claim **6**, further comprising sending the second propeller command for the second propeller.

8. The method of claim **1**,

wherein the first propeller is a plurality of first propellers, the first engine is a plurality of first engines, each of the first propellers associated with a respective first engine;

wherein the second propeller is a plurality of second propellers, the second engine is a plurality of second engines, each of the second propellers associated with a respective second engine;

wherein synchronizing the first propeller with the second propeller comprises synchronizing the plurality of first propellers with the plurality of second propellers by setting a plurality of first propeller commands for the plurality of first propellers based on the second requested engine power; and

sending the plurality of first propeller commands for the plurality of first propellers.

9. An aircraft subsystem comprising:

a first engine, a first propeller, and a first unified control lever associated with the first engine and the first propeller;

a second engine, a second propeller, and a second unified control lever associated with the second engine and the second propeller;

a first unified controller configured for controlling the first engine and the first propeller based on a first command from the first unified control lever; and

a second unified controller configured for controlling the second engine and the second propeller based on a second command from the second unified control lever;

wherein the first unified controller is configured for synchronizing the first propeller with the second propeller based on the second command from the second unified control lever.

10. An aircraft subsystem comprising:

a first engine, a first propeller, and a first unified control lever associated with the first engine and the first propeller;

a second engine, a second propeller, and a second unified control lever associated with the second engine and the second propeller;

a first unified controller configured for controlling the first engine and the first propeller based on a first command from the first unified control lever; and

a second unified controller configured for controlling the second engine and the second propeller based on a second command from the second unified control lever;

wherein the first unified controller and the second unified controller are configured for synchronizing the first propeller and the second propeller together.

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